"BALLANTINE" B-22

INSTRUCTIONS FOR

AC ELECTRONIC VOLTMETER

MODEL 300

THIS IS BOOK NO. 2

0309

BALLANTINE LABORATORIES, INC.
BOONTON, NEW JERSEY

THIS IS BOOK NO. 2

CONTENTS

	Page
Specifications	2
General	3
General Circuit Description	3
Operation	3
Input Impedance	4
Overload Characteristics	4
Effect of Wave Form	4
Measurement of Line Frequency Voltages	5
Measurement of Voltages Over 100 Volts	5
Measurement of Voltages Below One Millivolt	5
Measurement of Power Levels	6
Use As An Amplifier	7
Use As A Microammeter	7
Scale Range Adjustment	7
Servicing	8

SPECIFICATIONS

BALLANTINE MODEL 300
ELECTRONIC AC VOLTMETER

Frequency Range

10—150,000 cps

Voltage Range

1 millivolt to 100 volts rms in 5 decade ranges
(.01, .1, 1, 10 and 100 volts full scale)

Accuracy

2% up to 100 kc; 3% above 100 kc

Input Impedance

500,000 ohms shunted by a capacity of 30 $\mu\mu$f

Stability

Changes with variation in power supply voltage from 110 to 120 volts about 1%.

Scales

Logarithmic voltage scale reading from 1 to 10; auxiliary scale in decibels from 0 to 20. Each meter is hand calibrated.

Tubes

One 6J7, two 6SJ7, one 6H6, one 6X5 and two 991.
All tubes are supplied.

Amplifier Characteristics

Maximum voltage gain of 70 db; maximum output voltage is 30, output impedance is 15,000 ohms at maximum gain.
Flat within 1 db

Power Supply

110-120 volts, 50-60 cycles. 30 watts.

Dimensions

4½" high, 5¾" wide, 11" long

Weight

9½ pounds

INSTRUCTIONS FOR

AC ELECTRONIC VOLTMETER

MODEL 300

GENERAL—This voltmeter is designed to measure sinusoidal voltages from 1 millivolt to 100 volts over a frequency range from 10 to 150,000 cps. It operates from a 110-120 volt 60-cycle power supply. 220-volt models are also available on special order.

By means of a five decade range switch, the entire voltage range is indicated on a single logarithmic voltage scale reading from 1 to 10. The indicating meter also has a uniform decibel scale, numbered from 0 to 20 decibels. The zero of the decibel scale is arbitrarily arranged for maximum usefulness so as to correspond to 1 on the voltage scale

Its accuracy is 2% up to 100,000 cps and 3% above 100,000 cps. Since the scale is logarithmic the accuracy is the same at any point on the scale.

An ac output jack permits the amplifier section of the voltmeter to be used as a flat high gain amplifier with an adjustable gain from 0 to 70 db.

GENERAL CIRCUIT DESCRIPTION—The voltmeter employs a resistance-capacitance decade attenuator, a high-gain three stage negative feedback stabilized amplifier, a rectifier and a logarithmic indicating meter responding to the average values of the voltage wave but calibrated in rms values of a sine wave. Wire-wound resistors are used in the attenuator so as to insure a degree of stability otherwise unobtainable. The amplifier has sufficient feedback to render the indications of the voltmeter substantially independent of changes in line voltage, tubes, and other circuit components.

OPERATION—The voltmeter is supplied with tubes and is ready to operate as received. It is merely necessary to connect it to the ac power source and turn on the switch marked "ON-OFF." A pilot light is provided to indicate when power is on. The input terminal marked "GND" is connected to the case of the instrument and therefore, whenever possible, it should be connected to the ground of the circuit in which a voltage is being measured.

INPUT IMPEDANCE — The input impedance of the voltmeter is 500,000 ohms shunted by a capacitance of 30 $\mu\mu$f.

If a higher input impedance is desired and if it is not necessary to read less than 10 millivolts, the input impedance may be increased to 5 megohms shunted by 8 $\mu\mu$f by using the Ballantine Model 1300A Multiplier ahead of the voltmeter. If it is not necessary to read less than 100 millivolts, the input impedance may be increased to 40 megohms shunted by 3 $\mu\mu$f by using the Ballantine Model 1300B Multiplier ahead of the voltmeter.

Any direct current component of the wave under measurement is isolated from the voltmeter by means of a series input blocking capacitor of 400 volts rating. If dc voltages higher than this are applied an auxiliary protective network should be provided consisting of a 1 μf capacitor in series with the connection to the high potential input terminal and a 1 megohm resistor in shunt with the input terminals. An example of the use of such a network would be the measurement of commutator ripple on a 600-volt dynamotor.

OVERLOAD CHARACTERISTICS — The amplifier circuits are designed to saturate promptly when the voltage exceeds the full scale indication of the meter, thus protecting the indicating meter. This is a considerable advantage over other types of meters which may be seriously damaged by overloads such as the Model 300 Voltmeter will stand. The maximum voltage which can be safely tolerated on each range is as follows:

Range	Max. Voltage	Overload Ratio
.001 - .01	2	200
.01 - .1	20	200
.1 - 1	200	200
1 - 10	400	40
10 - 100	400	4

EFFECT OF WAVE FORM — The indications of the voltmeter are proportional to the average value of the ac wave under measurement. Since, however, it is primarily intended to measure sinusoidal waves its calibration is in terms of the rms value of a sinusoidal wave. Since electronic voltmeters of the input diode rectifier

type respond to the peak values of a wave, the readings of such meters and the present voltmeter will not necessarily agree when harmonics are present. The amount of the discrepancy will depend on the number and magnitude of the harmonics present as well as their phase relationship with respect to the fundamental. In all cases however, the departure of the readings from true rms values due to the presence of harmonics will be considerably less with an average responding meter such as the Model 300 than with a peak responding meter. For example in the case of a third harmonic whose amplitude is 20% of the fundamental the maximum error of a peak responding meter may be as much as 20% whereas the maximum error of an average responding meter such as the Model 300 will never exceed 6.7%.

Inasmuch as the Model 300 Voltmeter responds to the average value of the ac wave, "turn-over" discrepancies occasioned by any lack of symmetry of the wave such as are experienced in half-wave peak reading instruments are eliminated.

MEASUREMENT OF LINE FREQUENCY VOLTAGES—Even though the amount of residual hum in the voltmeter is extremely small, it may introduce slight inaccuracies (1 to 2%) in the readings at the lower end of the scale when the voltmeter is used to measure voltages having exactly the same frequency as that of the power supply mains. These inaccuracies may be eliminated by making two measurements, one with the power plug in normal polarity and the other with the power plug reversed. The mean of these readings will represent the true value of the voltage being measured.

MEASUREMENT OF VOLTAGES OVER 100 VOLTS—Multipliers are available to extend the range of the voltmeter to voltages above 100. The Model 1300A Multiplier extends the range by a factor of 10 up to 1,000 volts maximum. This has an input impedance of 5 megohms shunted by 8 $\mu\mu$f. The Model 1300B Multiplier extends the range by a factor of 100 to 10,000 volts and has an input impedance of 40 megohms shunted by 3 $\mu\mu$f.

MEASUREMENT OF VOLTAGES BELOW ONE MILLIVOLT—When voltages below one millivolt are to be measured we recommend the use of the Ballantine Decade Amplifier. This provides gains of exactly ten times or one hundred times and when connected ahead of the Model 300 Voltmeter permits measurements down to values as low as 20 microvolts.

MEASUREMENT OF POWER LEVELS — In view of the many different applications for Ballantine Voltmeters and the prevailing differences in power reference levels, it was felt inadvisable to relate the db scale to a particular level. Accordingly, in the interest of clarity and generality, the 0 of the db scale has been set arbitrarily at 1 on the voltage scale, and 20 db, therefore, corresponds to 10 on the voltage scale.

The most frequently used power reference levels are:

(1) dbm:———— Level in db referred to 1 milliwatt of power corresponding to 0.775 volts across a pure resistance of 600 ohms.

(2) Zero Level (a): — Level in db referred to 6 milliwatts of power corresponding to 1.897 volts across a pure resistance of 600 ohms.

(3) Zero Level (b): — Level in db referred to 6 milliwatts of power corresponding to 1.732 volts across a pure resistance of 500 ohms.

The following table enables a ready conversion from the db reading on the Ballantine Scale to the actual db power level for any of the various reference levels commonly in use.

MODEL 300 RANGE SWITCH SETTING	DB TO BE ADDED TO OR SUBTRACTED FROM THE DB READING ON THE BALLANTINE DB SCALE IN ORDER TO CONVERT TO THE DESIRED ZERO REFERENCE LEVEL		
	Zero Level 1mw-600 ohms	Zero Level 6mw-600 ohms	Zero Level 6mw-500 ohms
.01	—57.8	—65.6	—64.8
.1	—37.8	—45.6	—44.8
1	—17.8	—25.6	—24.8
10	+ 2.2	— 5.6	— 4.8
100	+22.2	+14.4	+15.2

USE AS AN AMPLIFIER — Inserting a standard tip and sleeve telephone plug into the output jack marked "AC OUTPUT" automatically disconnects the rectifier and the indicating meter and permits the amplifier section of the voltmeter to be used as a stable amplifier with a maximum gain of 70 db. The gain is adjustable in steps of 20 db by means of the range switch and finer adjustments in gain may be made by means of the knob marked "AC OUTPUT CONTROL." When the latter is set for maximum gain the output impedance of the amplifier is approximately 15,000 ohms. The amplifier will provide uniform voltage amplification within 1 db over the range from 10 to 150,000 cps when loaded by a resistance of not less than one megohm and a capacitance (including that of the telephone plug) of not more than 30 $\mu\mu$f. The hum and noise level present at the output jack when the instrument is used as an amplifier is less than 50 millivolts which is 55 db down from its maximum undistorted output voltage level of 30 volts. This hum and noise level is equivalent to less than 16 microvolts when referred to the input.

USE AS A MICROAMMETER—By using Ballantine Type 600 Precision Shunt Resistors in conjunction with this voltmeter, sinusoidal currents from 1 ampere down to 1 microampere can be measured over the frequency range from 10 to 150,000 cycles.

SCALE RANGE ADJUSTMENT—When the scale range adjustment is properly set a voltage input which produces a scale reading of 10 will produce a scale reading of 1 on the next higher range. No attention need be given to this adjustment except at very infrequent intervals but if some discrepancy is noted the required change in the adjustment should be made as follows: Allow the meter to warm up for five minutes. Connect a source of **pure** sinusoidal ac of any convenient frequency from 100 to 10,000 cps to the input. Adjust this voltage so that the meter reads 10 on any range other than the 100 volt range. Switch to the next higher range. The meter should read 1. If not remove the black button at the side of the case and adjust the exposed control with a screw-driver until the meter reads 1. Switch back to the lower range and check to see that it reads 10. If not readjust the input voltage to 10 and switch back to 1, readjusting with the screw-driver if necessary.

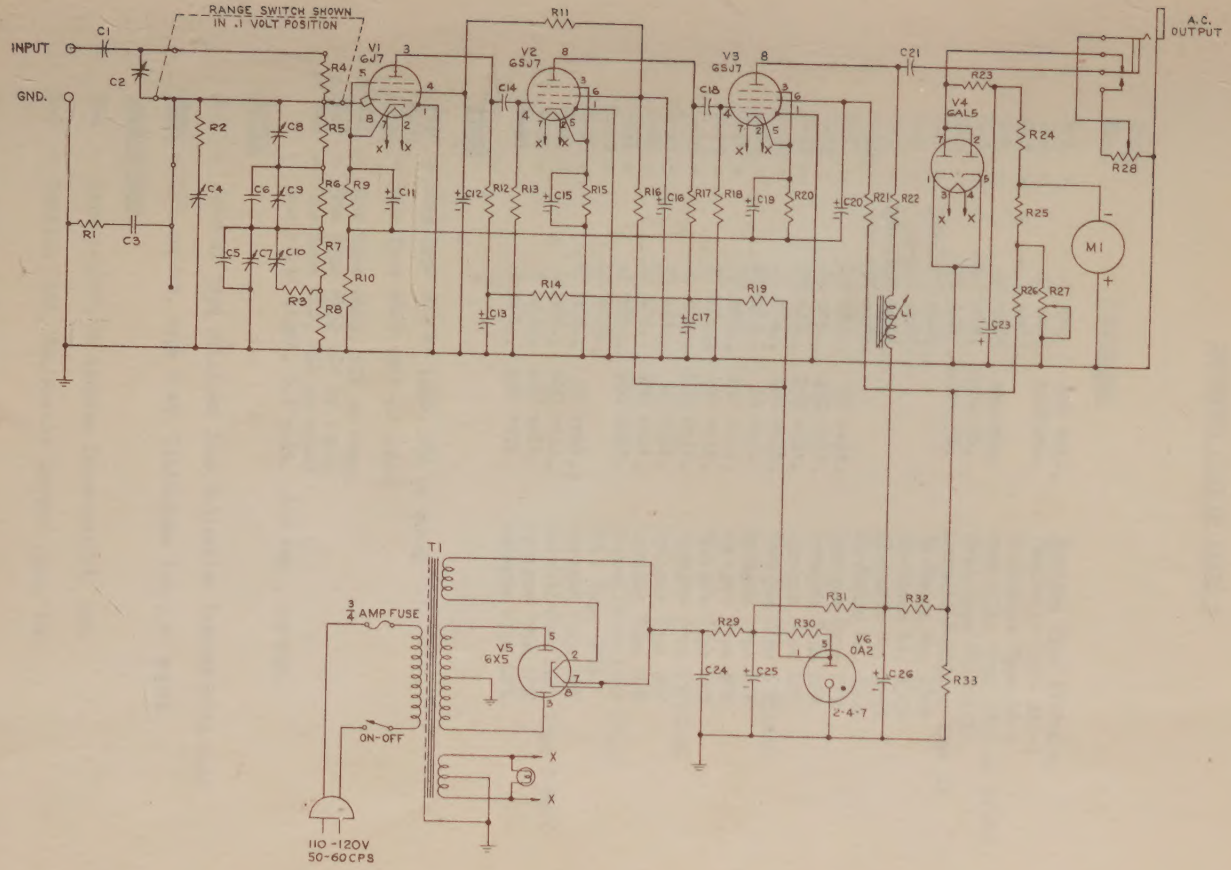
In the past some users of this instrument have misunderstood the purpose of this adjustment and have tried to use it to bring the needle

on the meter to 1 on the scale with no voltage applied to the input terminals. The indicating meter, being logarithmic, has no "zero." The normal position of the needle with no voltage applied to the input is against the left-hand stop and off scale. The meter should read only when a voltage within the range of the voltmeter is applied to its input terminals.

SERVICING — Servicing of this instrument by the user is not recommended except for scale range adjustment described on page 7 and except for the renewal of the fuse, pilot light, and tubes. If trouble develops which cannot be corrected by following these instructions, it is recommended that the instrument be returned to us for servicing. **Before returning the instrument please describe the trouble to us by letter** and we shall furnish shipping instructions.

The failure of the pilot light to light after the switch is turned on is an indication of either a blown fuse or a burned-out pilot light. The pilot light may be replaced from the front of the panel by merely unscrewing the red jewel. A three-quarter ampere fuse is mounted on the chassis inside the case. To renew the fuse first disconnect the instrument from the ac power line and after removing the four nickel-plated screws on the panel carefully lift out the panel from the case.

Spare fuses are provided and if additional fuses are required these may be ordered directly from Littelfuse, Inc., 4757 Ravenswood Avenue, Chicago, Illinois. The type number is 8AG, three-quarter ampere.


RANGE SWITCH SHOWN IN .1 VOLT POSITION
INPUT
GND.
C1
C2
R1
C3
R2
C4
R4
V1 6J7
R5
C8
C6
C9
R6
R9
C11
C5
C7
C10
R7
R10
R3
R8
R11
V2 6SJ7
C14
C12
R12
R13
C15
R15
C13
R14
V3 6SJ7
C18
R16
C16
R17
R18
C19
R20
C17
R19
C20
R21
R22
C21
L1
V4 6AL5
R23
R24
R25
R26
R27
C23
R28
A.C. OUTPUT
M1
T1
3/4 AMP FUSE
ON-OFF
110-120V 50-60CPS
V5 6X5
R29
R30
R31
R32
V6 0A2
2-4-7
C24
C25
C26
R33
X
X

MOD-300.

BALLENTINE

MOD-300.

www.manualsplus.com

1020030